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On the performance of topobathymetric LiDAR in shallow water environments: the Ribe Vesterå river and the Knudedyb tidal inlet in the Danish Wadden Sea

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Shallow water environments in the land-sea transition zone are challenging to map in high spatial resolution at large spatial scales. Historically this has led to gaps (white ribbons) between terrestrial and marine surveys. Topobathymetric LiDAR (Light Detection And Ranging), also referred to as green LiDAR which is able to penetrate through water, holds the potential to close this gap. However, water column turbidity poses limitations to the penetration of the green laser beam, and water column refraction of the laser beam poses limitations to the scale of features which can be resolved at the seabed.
The aim of this study is to investigate the performance of topobathymetric LiDAR in shallow water environments in relation to resolving small-scale morphological features at landscape scale. More specifically, the objectives are: 1) to determine the spatial resolution as well as the horizontal and vertical precision of green LiDAR based on object detection; and 2) to assess the potential of topobathymetric LiDAR as a tool to combine and integrate terrestrial and marine mapping and related investigations in the land-sea transition zone.
Topobathymetric LiDAR surveys were carried out in spring 2014 on an app. 7 km reach of the Ribe Vesterå river and in a 5 km x 10 km section of the Knudedyb tidal inlet in the Danish Wadden Sea using the airborne hydrographic laser scanner RIEGL® VQR-820-G. Prior to the surveys three geometrically defined objects (steel frames with dimensions of 0.8 m x 0.8 m x 0.25 m) were placed within the survey area in the river section, and in a back-barrier tidal channel and on a back-barrier salt marsh in the tidal inlet system, respectively. The exact locations of the three objects were determined by a Trimble® R8 GNSS Receiver.
The preliminary results show that the topobathymetric LiDAR system can detect the three objects. However, the sharp corners and edges of the objects are not perfectly resolved due to a combination of point density, which primarily is a function of effective measurement rate and flight height and speed, and seabed footprint size, which primarily is a function of water depth and water column refraction. The horizontal and vertical precision of the LiDAR system is at sub-decimetre scale at a 95% confidence level.
This suggests that topobathymetric LiDAR is capable of resolving relatively small-scale morphological features in challenging shallow water environments in the land-sea transition zone at landscape scale, as large spatial areas can be covered within short time, thereby enabling a closing of the historical gap between terrestrial and marine surveys.

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